09/940643

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03500.015

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	)	
	:	Examiner: Adolfo Nino
SHIN KITAMURA ET AL.	)	
	:	Group Art Unit: 2831
Appl. No.: 09/940,643	)	
	:	
Filed: August 29, 2001	)	
	:	
For: ELECTRON-EMITTING DEVICE, ELECTRON SOURCE, IMAGE-FORMING APPARATUS, AND METHOD FOR PRODUCING ELECTRON-EMITTING DEVICE AND IMAGE FORMING APPARATUS	)	
	:	
	)	
U.S. Patent No.: 6,848,962 B2	:	
	)	
Issued: February 1, 2005	:	June 3, 2005

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF CORRECTION
UNDER RULES 322 AND 323
AND REQUEST FOR REPRINTED
COVER PAGE OF LETTERS PATENT

Sir:

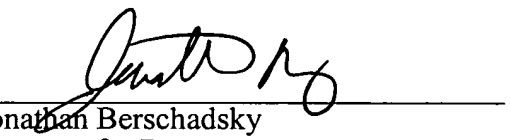
It is respectfully requested that a Certificate of Correction be issued by the Patent and Trademark Office due to errors which appear in the printed patent as a result of Patent and Trademark Office mistakes, and mistakes of a clerical, typographical, or minor character, which were not the fault of the Patent and Trademark Office. A Certificate of Correction form, in duplicate, is enclosed.

The enclosed Certificate of Correction notes an error on the cover page of the patent. It is respectfully requested that the cover page be reprinted to correct such error.

Accompanying this letter is a check for $100.00 to cover the statutory fee for such Certificate of Correction.

Patentees' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our address given below.

Respectfully submitted,



Jonathan Berschadsky
Attorney for Patentees
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CERTIFICATE OF CORRECTION

PATENT NO. : 6,848,962 B2

DATED : February 1, 2005

INVENTOR(S) : SHIN KITAMURA ET AL.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

COVER PAGE (54) TITLE

"ELECTRON-EMITTING APPARATUS" should read --IMAGE FORMING APPARATUS--.

COVER PAGE (56) FOREIGN PATENT DOCUMENTS

"JP 5-211029 8/1993 ..... H01J/1/30" should be deleted (duplication); and
"JP 8-115652 5/1996" should be deleted (duplication).

COVER PAGE (56) OTHER PUBLICATIONS

After "H. Dai et al.", "Disproportionati n" should read --Disproportionation--; and
After "M.I. Elinson et al.", "El ctrons" should read --Electrons--.

COLUMN 1

Line 5, "ELECTRON-EMITTING" should read --IMAGE-FORMING--.

COLUMN 2

Line 45, "le" should read --Ie--.

COLUMN 8

Line 16, "a" should read --an--;
Line 17, "a" should read --an--; and
Line 37, "millions)" should read --million×)--.

COLUMN 9

Line 19, "stable" should read --stably--; and
Line 66, "a" should read --an--.

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COLUMN 10

Line 33, "of" should read --on--.

COLUMN 12

Line 11, "becomes" should read --become--.

COLUMN 13

Line 50, "pieces" should read --piece--;
Line 56, "using the above men-" should be deleted; and
Line 57, "tioned matrix wiring" should be deleted.

COLUMN 16

Line 33, "1×10−4 Pa," should read --1×10^{-4} Pa,--.

COLUMN 17

Line 67, "In" should read --On--.

CLAIMS 1-42 SHOULD BE DELETED AND SUBSTITUTED WITH THE FOLLOWING CLAIMS 1-42:

--1. A method for producing an electron-emitting device, comprising the steps of:

(A) disposing a cathode electrode having a plurality of fibers on a surface of a substrate;

(B) providing an electrode opposite the cathode electrode; and

(C) applying a potential higher than a potential applied to the cathode electrode under a depressurized condition to an electrode opposite the cathode electrode,

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It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

wherein each fiber comprises a plurality of graphenes stacked in a direction that is not perpendicular to an axis direction of each fiber.

2. The method for producing an electron-emitting device, according to claim 1, wherein

said electrode opposite the cathode electrode is an anode electrode provided apart the substrate.

3. The method for producing an electron-emitting device, according to claim 1, wherein

said electrode opposite the cathode electrode is an extraction electrode for extracting electrons from at least one of the plurality of fibers, provided apart from the cathode electrode on the surface of the substrate.

4. The method for producing an electron-emitting device, according to claim 1, wherein

said step of applying the potential to the electrode opposite the cathode electrode is a step of increasing a number of emission sites.

5. The method for producing an electron-emitting device, according to claim 1, wherein

said potential applied to the electrode opposite the cathode electrode is a potential at which an electron is emitted from at least one of the plurality of fibers.

6. A method for producing an electron-emitting device according to Claim 5, wherein said step of applying the potential to the electrode opposite the cathode electrode includes a process of removing a part of the at least one fiber using heat due to electron emitting from the at least one fiber among the plurality of fibers.

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INVENTOR(S) : SHIN KITAMURA ET AL.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

7. The method for producing an electron-emitting device, according to claim 1, wherein

said step of applying the potential to the electrode opposite the cathode electrode is performed under a condition of a gas chemically or physically reactive to the plurality of fibers.

8. The method for producing an electron-emitting device, according to claim 7, wherein

said gas chemically reactive to the plurality of fibers is one of O_2, H_2, CO_2, and H_2O.

9. The method for producing an electron-emitting device, according to claim 7, wherein

a pressure for introducing the gas is equal to or over 1×10^{-4} Pa.

10. The method for producing an electron-emitting device, according to claim 7, wherein

said step of applying the potential to the electrode opposite the cathode electrode is a step of applying a pulse voltage between the cathode electrode and the electrode opposite the cathode electrode.

11. The method for producing an electron-emitting device, according to claim 1, wherein

the plurality of fibers are formed by decomposing a hydrocarbon gas.

12. The method for producing an electron-emitting device, according to claim 11, wherein

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INVENTOR(S) : SHIN KITAMURA ET AL.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

the plurality of fibers are formed by decomposing the hydrocarbon gas using a catalyst provided on the cathode electrode in advance.

13. The method for producing an electron-emitting device, according to claim 12, wherein

said catalyst is one of Fe, Co, Pd, and Ni, or an alloy consisting of materials selected from among Fe, Co, Pd, and Ni.

14. A method for producing an electron source obtained by arranging a plurality of electron-emitting devices, which are each produced according to the method of any one of claims 1 to 13.

15. A method for producing an image-forming apparatus having an electron source and an image-forming member, wherein

said electron source is produced according to the method of claim 14.

16. A method for producing an electron source having a plurality of electron-emitting devices, comprising the steps of:

(A) providing on a substrate a plurality of electron-emitting devices comprising plural pieces of fiber containing carbon, and plural pieces of wiring electrically connected to at least one of the plurality of electron-emitting devices;

(B) measuring by applying a voltage to at least a part of the plurality of electron-emitting devices, an electrical characteristic of said at least a part of the plurality of electron-emitting devices to which the voltage is applied;

(C) reducing a difference in electrical characteristic among the plurality of electron-emitting devices based on a measurement result, wherein

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It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

said step of reducing the difference in characteristic among the plurality of electron-emitting devices comprising a step of emitting an electron from at least one of the plurality of electron-emitting devices under depressurized condition.

17. The method for producing an electron source, according to claim 16, wherein

said plural pieces of wiring comprise plural pieces of row direction wirings, and plural pieces of column direction wirings crossing the row direction wirings, and each of the electron-emitting devices is connected to one of the row direction wirings and one of the column direction wirings.

18. The method for producing an electron source, according to claim 17, wherein

said step of reducing the difference in characteristic among the plurality of electron-emitting devices contains a step of emitting an electron from a desired electron-emitting device by repeating a step of selecting from said plural pieces of column direction wirings or said plural pieces of row direction wirings, a part of the pieces of column direction wirings or row direction wirings, and emitting an electron from an electron-emitting device connected to the selected wiring.

19. The method for producing an electron source, according to claim 16, wherein

said step of reducing the difference in characteristic among the plurality of electron-emitting devices contains a step of emitting an electron from a desired electron-emitting device by repeating a step of selecting a part of electron-emitting devices from among the plurality of electron-emitting devices and emitting an electron from the selected electron-emitting device.

20. The method for producing an electron source, according to claim 16, wherein:

said electron-emitting device contains a cathode electrode to which the fiber is electrically connected, and an extracting electrode provided apart from the cathode electrode; and

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said step of emitting an electron from the at least one electron-emitting device is performed by applying a voltage between the cathode electrode and the extracting electrode.

21. The method for producing an electron source, according to claim 16, wherein

said step of emitting an electron from the at least one electron-emitting device is performed by applying a voltage between an electrode provided apart from the substrate and the electron-emitting device.

22. The method for producing an electron source, according to claim 16, wherein

said electron-emitting device contains a cathode electrode to which the fiber is electrically connected, and an extracting electrode provided apart from the cathode electrode; and

said step of emitting an electron from the at least one electron-emitting device is performed by applying a potential difference between an electrode provided apart from the substrate and the electron-emitting device.

23. The method for producing an electron source, according to claim 16, wherein

said step of reducing the difference in characteristic among the plurality of electron-emitting devices is a step of increasing a number of emission sites of at least one electron-emitting device.

24. The method for producing an electron source, according to claim 16, wherein

said step of reducing the difference in characteristic among the plurality of electron-emitting devices is performed in ambient of a gas chemically or physically reactive to the fiber.

25. The method for producing an electron source, according to claim 24, wherein

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CERTIFICATE OF CORRECTION

PATENT NO. : 6,848,962 B2

DATED : February 1, 2005

INVENTOR(S) : SHIN KITAMURA ET AL.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

said gas chemically reactive to the fiber contains a gas selected at least from among O_2, H_2, CO_2, and H_2O.

26. The method for producing an electron source, according to claim 25, wherein a pressure for introducing the gas is equal to or over 1×10^{-4} Pa.

27. The method for producing an electron source, according to claim 24, wherein said step of emitting an electron from at least one of the plurality of electron-emitting devices is performed by applying a pulse voltage to the at least one electron-emitting device.

28. The method for producing an electron source, according to claim 16, wherein said plural pieces of fiber are formed by decomposing a hydrocarbon gas.

29. The method for producing an electron source, according to claim 16, wherein said plural pieces of fiber are formed by decomposing hydrocarbon gas using a catalyst provided on the cathode electrode in advance.

30. The method for producing an electron source, according to claim 29, wherein said catalyst is one of Fe, Co, Pd, and Ni, or an alloy consisting of materials selected from among Fe, Co, Pd, and Ni.

31. The method for producing an electron source, according to claim 16, wherein said fiber is formed by graphite nanofiber, carbon nanotube, or amorphous carbon fiber.

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It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

32. The method for producing an electron source, according to claim 16, wherein said fiber comprises a graphene.

33. The method for producing an electron source, according to claim 16, wherein said fiber comprises a plurality of graphenes.

34. The method for producing an electron source, according to claim 33, wherein said plurality of graphenes are stacked in a direction that is not perpendicular to an axis direction of each fiber.

35. A method for producing an image-forming apparatus having an electron source and an image-forming member, wherein said electron source is produced according to the method of any one of claims 16 to 34.

36. The method for producing an image-forming apparatus, according to claim 35, wherein said image-forming apparatus is obtained by seal bonding a first substrate provided with the image-forming member with a second substrate provided with the electron source, and an electrical characteristic of at least one of the electron-emitting devices is measured before the first and second substrates are seal bonded with each other.

37. The method for producing an image-forming apparatus, according to claim 35, wherein said image-forming apparatus is obtained by seal bonding a first substrate provided with the image-forming member with a second substrate provided with the electron source, and said step of reducing the difference in electrical characteristic among the plurality

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of electron-emitting devices is performed before the first and second substrates are seal bonded with each other.

38. A method for producing an electron-emitting device, comprising the steps of:

(A) disposing a cathode electrode having a plurality of fibers, on a surface of a substrate;

(B) providing an electrode opposite the cathode electrode; and

(C) applying a potential higher than a potential applied to the cathode electrode under a depressurized condition to the electrode opposite the cathode electrode,

wherein said step of applying the potential to the electrode opposite the cathode electrode is a step of increasing a number of emission sites.

39. A method for producing an electron source having a plurality of electron-emitting devices, comprising the steps of:

providing on a substrate a plurality of electron-emitting devices comprising plurality pieces of fiber; and

reducing a difference in electron emission characteristics among the plurality of electron-emitting devices,

wherein said step of reducing comprises a step of emitting electrons from at least one of the plurality of electron-emitting devices under a depressurized condition, and

wherein each fiber comprises a plurality of graphenes stacked in a direction that is not perpendicular to an axis direction of each fiber.

40. A method for producing an electron source having a plurality of electron-emitting devices, comprising the steps of:

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providing on a substrate a plurality of electron-emitting devices comprising plural pieces of fiber;

identifying at least one lowest electron-emitting device having a lowest electron emission threshold voltage among the plurality of electron-emitting devices; and

shifting each electron emission threshold voltage of electron-emitting devices other than the at least one lowest electron-emitting device, so as to become closer to the lowest electron emission threshold voltage, by performing an electron emission from the electron-emitting devices other than the at least one lowest electron-emitting device, under a depressurized condition.

41. The method of producing an electron source, according to claim 40, wherein each fiber comprises a plurality of graphenes stacked in a direction that is not perpendicular to an axis direction of each fiber.

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42. A method for producing an electron-emitting device, comprising the steps of:

(A) disposing a cathode electrode having a plurality of fibers on a surface of a substrate;

(B) providing an electrode opposite the cathode electrode; and

(C) applying a potential higher than a potential applied to the cathode electrode under a depressurized condition to an electrode opposite the cathode electrode,

wherein each fiber comprises a plurality of graphenes which are stacked so as not to be parallel to an axis direction of each fiber.--

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COLUMN 16

Line 33, "1×10−4 Pa," should read --1×10^{-4} Pa,--.

COLUMN 17

Line 67, "In" should read --On--.

CLAIMS 1-42 SHOULD BE DELETED AND SUBSTITUTED WITH THE FOLLOWING CLAIMS 1-42:

--1. A method for producing an electron-emitting device, comprising the steps of:

(A) disposing a cathode electrode having a plurality of fibers on a surface of a substrate;

(B) providing an electrode opposite the cathode electrode; and

(C) applying a potential higher than a potential applied to the cathode electrode under a depressurized condition to an electrode opposite the cathode electrode,

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wherein each fiber comprises a plurality of graphenes stacked in a direction that is not perpendicular to an axis direction of each fiber.

2. The method for producing an electron-emitting device, according to claim 1, wherein

said electrode opposite the cathode electrode is an anode electrode provided apart the substrate.

3. The method for producing an electron-emitting device, according to claim 1, wherein

said electrode opposite the cathode electrode is an extraction electrode for extracting electrons from at least one of the plurality of fibers, provided apart from the cathode electrode on the surface of the substrate.

4. The method for producing an electron-emitting device, according to claim 1, wherein

said step of applying the potential to the electrode opposite the cathode electrode is a step of increasing a number of emission sites.

5. The method for producing an electron-emitting device, according to claim 1, wherein

said potential applied to the electrode opposite the cathode electrode is a potential at which an electron is emitted from at least one of the plurality of fibers.

6. A method for producing an electron-emitting device according to Claim 5, wherein said step of applying the potential to the electrode opposite the cathode electrode includes a process of removing a part of the at least one fiber using heat due to electron emitting from the at least one fiber among the plurality of fibers.

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7. The method for producing an electron-emitting device, according to claim 1, wherein

said step of applying the potential to the electrode opposite the cathode electrode is performed under a condition of a gas chemically or physically reactive to the plurality of fibers.

8. The method for producing an electron-emitting device, according to claim 7, wherein

said gas chemically reactive to the plurality of fibers is one of O_2, H_2, CO_2, and H_2O.

9. The method for producing an electron-emitting device, according to claim 7, wherein

a pressure for introducing the gas is equal to or over 1×10^{-4} Pa.

10. The method for producing an electron-emitting device, according to claim 7, wherein

said step of applying the potential to the electrode opposite the cathode electrode is a step of applying a pulse voltage between the cathode electrode and the electrode opposite the cathode electrode.

11. The method for producing an electron-emitting device, according to claim 1, wherein

the plurality of fibers are formed by decomposing a hydrocarbon gas.

12. The method for producing an electron-emitting device, according to claim 11, wherein

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PATENT NO. 6,848,962 B2

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CERTIFICATE OF CORRECTION

PATENT NO. : 6,848,962 B2

DATED : February 1, 2005

INVENTOR(S) : SHIN KITAMURA ET AL.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

the plurality of fibers are formed by decomposing the hydrocarbon gas using a catalyst provided on the cathode electrode in advance.

13. The method for producing an electron-emitting device, according to claim 12, wherein

said catalyst is one of Fe, Co, Pd, and Ni, or an alloy consisting of materials selected from among Fe, Co, Pd, and Ni.

14. A method for producing an electron source obtained by arranging a plurality of electron-emitting devices, which are each produced according to the method of any one of claims 1 to 13.

15. A method for producing an image-forming apparatus having an electron source and an image-forming member, wherein

said electron source is produced according to the method of claim 14.

16. A method for producing an electron source having a plurality of electron-emitting devices, comprising the steps of:

(A) providing on a substrate a plurality of electron-emitting devices comprising plural pieces of fiber containing carbon, and plural pieces of wiring electrically connected to at least one of the plurality of electron-emitting devices;

(B) measuring by applying a voltage to at least a part of the plurality of electron-emitting devices, an electrical characteristic of said at least a part of the plurality of electron-emitting devices to which the voltage is applied;

(C) reducing a difference in electrical characteristic among the plurality of electron-emitting devices based on a measurement result, wherein

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said step of reducing the difference in characteristic among the plurality of electron-emitting devices comprising a step of emitting an electron from at least one of the plurality of electron-emitting devices under depressurized condition.

17. The method for producing an electron source, according to claim 16, wherein

said plural pieces of wiring comprise plural pieces of row direction wirings, and plural pieces of column direction wirings crossing the row direction wirings, and each of the electron-emitting devices is connected to one of the row direction wirings and one of the column direction wirings.

18. The method for producing an electron source, according to claim 17, wherein

said step of reducing the difference in characteristic among the plurality of electron-emitting devices contains a step of emitting an electron from a desired electron-emitting device by repeating a step of selecting from said plural pieces of column direction wirings or said plural pieces of row direction wirings, a part of the pieces of column direction wirings or row direction wirings, and emitting an electron from an electron-emitting device connected to the selected wiring.

19. The method for producing an electron source, according to claim 16, wherein

said step of reducing the difference in characteristic among the plurality of electron-emitting devices contains a step of emitting an electron from a desired electron-emitting device by repeating a step of selecting a part of electron-emitting devices from among the plurality of electron-emitting devices and emitting an electron from the selected electron-emitting device.

20. The method for producing an electron source, according to claim 16, wherein:

said electron-emitting device contains a cathode electrode to which the fiber is electrically connected, and an extracting electrode provided apart from the cathode electrode; and

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said step of emitting an electron from the at least one electron-emitting device is performed by applying a voltage between the cathode electrode and the extracting electrode.

21. The method for producing an electron source, according to claim 16, wherein

said step of emitting an electron from the at least one electron-emitting device is performed by applying a voltage between an electrode provided apart from the substrate and the electron-emitting device.

22. The method for producing an electron source, according to claim 16, wherein

said electron-emitting device contains a cathode electrode to which the fiber is electrically connected, and an extracting electrode provided apart from the cathode electrode; and

said step of emitting an electron from the at least one electron-emitting device is performed by applying a potential difference between an electrode provided apart from the substrate and the electron-emitting device.

23. The method for producing an electron source, according to claim 16, wherein

said step of reducing the difference in characteristic among the plurality of electron-emitting devices is a step of increasing a number of emission sites of at least one electron-emitting device.

24. The method for producing an electron source, according to claim 16, wherein

said step of reducing the difference in characteristic among the plurality of electron-emitting devices is performed in ambient of a gas chemically or physically reactive to the fiber.

25. The method for producing an electron source, according to claim 24, wherein

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said gas chemically reactive to the fiber contains a gas selected at least from among O_2, H_2, CO_2, and H_2O.

26. The method for producing an electron source, according to claim 25, wherein a pressure for introducing the gas is equal to or over 1×10^{-4} Pa.

27. The method for producing an electron source, according to claim 24, wherein said step of emitting an electron from at least one of the plurality of electron-emitting devices is performed by applying a pulse voltage to the at least one electron-emitting device.

28. The method for producing an electron source, according to claim 16, wherein said plural pieces of fiber are formed by decomposing a hydrocarbon gas.

29. The method for producing an electron source, according to claim 16, wherein said plural pieces of fiber are formed by decomposing hydrocarbon gas using a catalyst provided on the cathode electrode in advance.

30. The method for producing an electron source, according to claim 29, wherein said catalyst is one of Fe, Co, Pd, and Ni, or an alloy consisting of materials selected from among Fe, Co, Pd, and Ni.

31. The method for producing an electron source, according to claim 16, wherein said fiber is formed by graphite nanofiber, carbon nanotube, or amorphous carbon fiber.

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It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

32. The method for producing an electron source, according to claim 16, wherein said fiber comprises a graphene.

33. The method for producing an electron source, according to claim 16, wherein said fiber comprises a plurality of graphenes.

34. The method for producing an electron source, according to claim 33, wherein said plurality of graphenes are stacked in a direction that is not perpendicular to an axis direction of each fiber.

35. A method for producing an image-forming apparatus having an electron source and an image-forming member, wherein said electron source is produced according to the method of any one of claims 16 to 34.

36. The method for producing an image-forming apparatus, according to claim 35, wherein said image-forming apparatus is obtained by seal bonding a first substrate provided with the image-forming member with a second substrate provided with the electron source, and an electrical characteristic of at least one of the electron-emitting devices is measured before the first and second substrates are seal bonded with each other.

37. The method for producing an image-forming apparatus, according to claim 35, wherein said image-forming apparatus is obtained by seal bonding a first substrate provided with the image-forming member with a second substrate provided with the electron source, and said step of reducing the difference in electrical characteristic among the plurality

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of electron-emitting devices is performed before the first and second substrates are seal bonded with each other.

38. A method for producing an electron-emitting device, comprising the steps of:

(A) disposing a cathode electrode having a plurality of fibers, on a surface of a substrate;

(B) providing an electrode opposite the cathode electrode; and

(C) applying a potential higher than a potential applied to the cathode electrode under a depressurized condition to the electrode opposite the cathode electrode,

wherein said step of applying the potential to the electrode opposite the cathode electrode is a step of increasing a number of emission sites.

39. A method for producing an electron source having a plurality of electron-emitting devices, comprising the steps of:

providing on a substrate a plurality of electron-emitting devices comprising plurality pieces of fiber; and

reducing a difference in electron emission characteristics among the plurality of electron-emitting devices,

wherein said step of reducing comprises a step of emitting electrons from at least one of the plurality of electron-emitting devices under a depressurized condition, and

wherein each fiber comprises a plurality of graphenes stacked in a direction that is not perpendicular to an axis direction of each fiber.

40. A method for producing an electron source having a plurality of electron-emitting devices, comprising the steps of:

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providing on a substrate a plurality of electron-emitting devices comprising plural pieces of fiber;

identifying at least one lowest electron-emitting device having a lowest electron emission threshold voltage among the plurality of electron-emitting devices; and

shifting each electron emission threshold voltage of electron-emitting devices other than the at least one lowest electron-emitting device, so as to become closer to the lowest electron emission threshold voltage, by performing an electron emission from the electron-emitting devices other than the at least one lowest electron-emitting device, under a depressurized condition.

41. The method of producing an electron source, according to claim 40, wherein each fiber comprises a plurality of graphenes stacked in a direction that is not perpendicular to an axis direction of each fiber.

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42. A method for producing an electron-emitting device, comprising the steps of:

(A) disposing a cathode electrode having a plurality of fibers on a surface of a substrate;

(B) providing an electrode opposite the cathode electrode; and

(C) applying a potential higher than a potential applied to the cathode electrode under a depressurized condition to an electrode opposite the cathode electrode,

wherein each fiber comprises a plurality of graphenes which are stacked so as not to be parallel to an axis direction of each fiber.--

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